Decadal Survey History and Strategy

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Far IR STDT

5/12/16

Early JWST History

- 1989, before HST launch, conference at STScI, published proceedings, outlined options, with some good cost estimates (!)
- 1990 HST launch – 26 years old now!
- 1993 HST repair mission (1st of 5 servicing missions)
- 1995 HST & Beyond report drafted, JWST study started at GSFC with HQ direction, under HST project manager
- Concept developed within weeks at STScI/GSFC meeting
- Dressler & Goldin met and understood concept and challenge
- Announcement of program by D. Goldin at AAS meeting, January 1996, got standing ovation (there's peer review!)
- Mather presented concept to ESA officials January 1996 – interest + cost and schedule skepticism

3 competing studies

- Presentation by NASA to industry at STScI in spring 1996 – industry requested a competition via “cooperative agreement notice”
- Huge interest – top scientists and engineers volunteered to work on most exciting project
- NASA/STScI team, Lockheed Martin team, TRW team, reported summer 1996; all agreed that Goldin challenge ($500 M FY 96 for NASA) can be met (but we all obviously missed something!)
- Major aerospace contractors all could win work – JWST had many friends!
- OMB examiner saw web site, was very interested
- NASA presented baseline of 1-5 µm telescope for budget purposes and was approved to continue; 5-28 µm extension was not formally submitted

Technology Developments

- Detectors (essential) – GSFC mgmt
- ASICs (essential) – GSFC mgmt
- Mirrors (eventually 12 contracts) – MSFC mgmt, DoD/ NRO agreement for joint support
- Micromirror/microshutter arrays – HQ selection of GSFC team
- Later, 7 K coolers (solid Hydrogen too heavy) – JPL mgmt of Northrop Grumman cooler
- Wavefront sensing and control – JPL initiated in-house
- Deployments
- Sunshield materials and deployments

Science Teams

- Volunteer SWG and Cooperative Agreement teams
- ASWG (Ad Hoc Science Working Group – HQ selected) – developed Design Reference Mission by voting on ~ 25 inputs
- Used as basis for instrument definition, international partnership agreement
- ISWG (Interim Science Working Group) – HQ selected
- SWG, 2002 selection by HQ, with instrument team GTOs, Interdisciplinary Scientists

Decadal Survey 2000

- Intense competition (of course)
- "Faster Better Cheaper" mantra was dominant for NASA
  - Huge ambitions, "proof by analysis", desire to take risk to get reward, belief that there was a better way
- Costs were not formally submitted by NASA, but Decadal committee had to do something
- JWST was given top rating for large space missions
- SIM was a medium mission, endorsed and assumed to be launching ~ 2005
- UV/Optical proposal for a 4 m aperture system was not endorsed – not enough better than HST

JWST at the 2000 Decadal

- Science case: HST & Beyond report is brilliant & poetic
- Uniqueness: impossible to do sensitive IR astronomy from the ground (> 1.7 μm)
- Discovery potential: huge jump in capability over Spitzer (not yet launched), with 10 x aperture, AND over HST (3.3 x aperture)
- Killer app: first stars and galaxies require 8 m aperture, cold IR telescope
- General purpose: imaging and spectroscopy over whole band from 0.6 to 28 μm possible (though mid IR not confirmed yet)
- Technology roadmap, plan to complete to TRL6 before completing design (HST lesson learned)
- Initial progress on mirror technology good
- International partnerships with ESA and CSA very supportive, details still TBD

JWST Team Selections

- International partnership discussion led to assigned roles – CSA for FGS/NIRISS, ESA for NIRSpec and Ariane 5, JPL/ European consortium for MIRI
- Descope to 6.5 m prior to competition for prime contract
- US instrument NIRCam competition, 2002
- Interdisciplinary scientists & SWG chosen, 2002
- Prime contract 2002 (TRW and Lockheed Martin both supported through Phase A)
- Immediate cost growth and further descopes after selecting TRW
- TRW group → Northrop Grumman
- NGST → JWST

Near Death Experience 2011

- JWST budget requests continued to grow
- Head of House committee zeros the budget, Mikulski writes to NASA asking for technical review and new plan
- Review says engineering excellent, sometimes brilliant, but did not ask for enough money
- Congress agrees to new budget including adequate schedule contingency based on statistical tool: $8.00 B to launch in October 2018
- Money came, project stays on track ever since

JWST status

- Telescope assembled
- Instrument module tested 3x in cryo vac
- Instrument module and telescope to combine at GSFC, have vibration and acoustic test
- Ship telescope to JSC near New Year's for cold focus and functional test, about 1 year
- Integration to spacecraft at Northrop Grumman (Redondo Beach)
- Launch by Ariane 5 from French Guiana, Oct. 2018
- Commissioning complete Apr. 2019

4 Science Themes to Define JWST capabilities*

- First Light: first stars, first black holes, first galaxies (the most difficult technically)
- Galaxy assembly: how they change with time, how black holes affect them, how they cluster
- Star and planetary system formation: looking inside dusty clouds
- Planets and life: solar system and exoplanets

*: Only for construction; observers not restricted

Key Far IR similarities to JWST

- Huge jump in capabilities
- Unique: no way to do it on the ground
- Competitors maturing: JWST (< 28 μm), ALMA (> 270 μm)
- Possible killer apps: star/planet formation, follow the water, high-z universe
- Something for every astronomer: general purpose instruments, imaging and spectroscopy
- Serious new technologies – very cold optics, very large mirrors, interferometry, better/larger direct detectors, better/higher frequency heterodyne front and back ends, new photon spectrometers (Bradford, Moseley, et al.)
- Could be based on scaled JWST design
- International partnership opportunity: worldwide interest, plenty of work to go around